LANCET 1977 1: 1341 - 1343.

ceived vaccine and 6012 received a saline placebo. In the rst 3 years after vaccination 303 people died—170 placebo nd 133 vaccine. This represents a 22% difference in mortality nd a crude difference of almost 2 deaths per 1000 persons. he difference was largely due to fewer deaths from respiraory causes (table IV). The most significant difference was in eaths from pneumonia uncomplicated by chronic lung disase—41 placebo and 23 vaccine. This represents a 42% difference in mortality which is significant at the $P<0.05$ level, test. There was far less protection given to persons suffering rom chronic lung disease (table V).

During an epidemic of influenza in early 1976 there were 25 eaths due to respiratory causes—16 placebo and 9 vaccine. he difference is not significant but does suggest a protection ate of 40% which is consistent with other results.

Discussion

The vaccine reduced the alveolar multiplication of pneumococci and their invasion of the bloodstream, but had little effect on their invasion of the lower respiratory ract. The severity rather than the incidence of pneumonia was affected, and mortality-rates were reduced ccordingly.

These results differ in some ways from those reported by MacLeod et al. in 1945,[8] and more recently by Austrian et al.[9] Both these trials of pneumococcal polysaccharide vaccine dealt with large populations of young men: U.S. Army recruits and South African mine workers respectively. The incidence of pneumonia was high, and this could largely be attributed to the exposure of healthy recruits to respiratory pathogens with which they had no previous contact. Immunisation not only reduced the incidence of pneumonia and of blood-borne pneumococcal invasion, but also reduced sputum and nasopharyngeal isolation rates of the organisms.

The susceptibility of the Huli people to pneumonia has several causes. They live in poorly ventilated, smoky huts and are often exposed to a cold wet climate; chronic lung disease with associated damage to respiratory defences and bacterial contamination of the respiratory tract is common. This, together with the comparatively high pre-immunisation levels of antibody, may explain why the vaccine had no effect on sputum and nasopharyngeal isolation of the pneumococcus.

Two important facts emerge from this study: the vaccine has reduced mortality from pneumonia, and the reduction occurred steadily over 3 years. The steady decline is consistent with earlier findings that the level of antibodies to pneumococcal polysaccharide remains at half its maximum value 5 years after immunisation.[10] The reduction in mortality is clearly important to health care in the underdeveloped world. The vaccine is a useful adjunct to primary health-care services. It may alleviate the crippling effects of influenza on Highlands communities.

The trial was supported by the Department of Public Health, Papua New Guinea, and by a grant from Merck, Sharp and Dohme Limited, who also provided the vaccine. Serum-antibody estimations were performed by Dr M. D. Bonner in the laboratories of Prof. R. Austrian. Field work was carried out by B. Iwais, K. Kipusin, J. Borwick, P. Agaju, D. Kane, D. Holliday, and many others. We gratefully acknowledge the encouragement of Dr R. F. R. Scragg and of Professor Austrian.

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COMPARISON OF ORAL 25-HYDROXYCHOLECALCIFEROL, VITAMIN D, AND ULTRAVIOLET LIGHT AS DETERMINANTS OF CIRCULATING 25-HYDROXYVITAMIN D

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Summary Circulating concentrations of 25-hydroxyvitamin D (25-OHD) were measured during short-term and long-term oral treatment with 25-hydroxycholecalciferol (25-OHD_3, 25-H.C.C.) or with vitamin D in over 200 subjects over a period of 5 years. Ten times more vitamin D than 25-OHD_3 was required to produce equivalent plasma-25-OHD concentrations. Plasma-25-OHD was a power function of dosage with both compounds. These data indirectly measure the superior therapeutic potency of 25-OHD_3, show that dose-response relations with both compounds may be useful in diagnosis, and indicate that there are pronounced constraints on 25-hydroxylation of vitamin D. Together with the effects of ultraviolet light, now shown to be equivalent to oral vitamin D in doses of 8000–10 000 I.U. daily, these constraints may protect against vitamin-D deficiency in winter.

Introduction

PLASMA-25-HYDROXYVITAMIN-D (25-OHD) is often measured as an index of response to various forms of vitamin-D treatment. Although preliminary data have been obtained during pharmacological oral dosage,[1] analysis of plasma-25-OHD as a function of dosage is lacking. 25-hydroxycholecalciferol (25-OHD_3, 25-H.C.C.) is several times more potent than the parent vitamin, but reports of its therapeutic efficacy have not included systematic measurement of plasma concentrations.[2-5] Vitamin D is a pro-hormone[6] which only becomes active on transformation to its 25-hydroxy derivative, a process that is subject to pronounced but poorly understood constraints.[7-9]

Comprehensive comparison of plasma-25-OHD concentrations during treatment with the two compounds should both clarify the extent of these constraints in man and indirectly measure the relative therapeutic potencies of the two compounds. As a further result, previous data on natural[10] and artificial[11,12] ultraviolet light could be more critically evaluated.

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Subjects and Methods

Most of the data came from patients requiring treatment with vitamin D for various conditions including classic deficiency, X-linked hypophosphatæmic ("vitamin-D resistant") rickets or osteomalacia, osteoporosis, and hypoparathyroidism. Patients with disorders expected to interfere with intestinal vitamin-D absorption or with hepatic 25-hydroxylation were not included; patients were also excluded if their compliance with treatment was in doubt. Some healthy adult volunteers were also studied. Long-term solar irradiation and daily whole-body artificial ultraviolet light (U.V.L.) were studied as reported elsewhere.[10,12] Plasma-25-OHD was measured in triplicate by a radio-competitive assay.[10] Supplies of 25-OHD$_3$ for treatment were a gift from Dr J. C. Babcock of the Upjohn Company. Vitamin D was given either as ergocalciferol or as cholecalciferol.

Results

Steady-state concentrations of 25-OHD in 128 subjects receiving long-term (⩾ four months) treatment with vitamin D$_2$ or D$_3$ and among subjects receiving 25-OHD$_3$ (for at least six weeks) are shown in fig. 1.

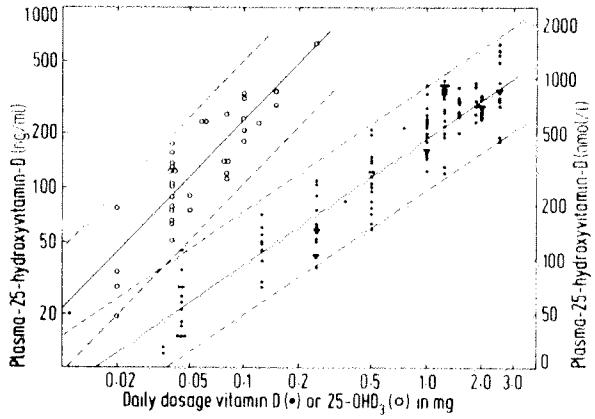

Fig. 1—Plasma-25-OHD in 164 subjects receiving daily long-term treatment with vitamin D$_2$ or D$_3$ (●) and with 25-OHD$_3$ (○) in different doses.

Regression lines (with 95% confidence limits) are given for each form of treatment. Mean value (±1S.D.) in 8 lifeguards in midsummer was 64·4±8·7 ng/ml.[10]

Although plasma-25-OHD varied widely for any given dose, there was a clear log/log relation between plasma-25-OHD (ng/ml) and vitamin-D dosage in μg (r=0·94) given by the equation:

$$\log y = 0{\cdot}178 + 0{\cdot}701 \log x.$$

During treatment with 25-OHD$_3$ itself, plasma 25-OHD was also a power function of dosage (r=0·86), the relation in 36 subjects being given by the equation;

$$\log y = 0{\cdot}285 + 1{\cdot}039 \log x.$$

Thus the potency of 25-OHD$_3$ relative to vitamin D increased steadily with dosage—e.g., on a molar basis 9 and 12 times more vitamin D was required to produce mean plasma-25-OHD concentrations of 250 and 500 nmol/l (100 and 200 ng/ml), respectively, and 25-OHD$_3$ in daily dosage of 50 and 100 μg produced mean 25-OHD concentrations which were respectively 5 and 6 times higher than with vitamin D.

Fig. 2 shows changes in plasma-25-OHD during

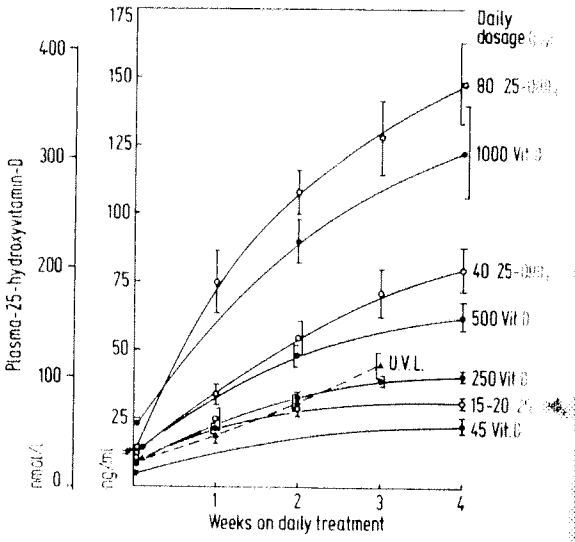

Fig. 2—Mean plasma-25-OHD in 60 subjects during short-[illegible] treatment with vitamin D$_2$ of D$_3$ (●) or with 25-OHD$_3$.

(○) in different daily doses (as shown). ▲=mean 25-OHD in [illegible] jects receiving daily artificial U.V.L.[12] Bars indicate S.E.M.

short-term treatment with vitamin D or 25-OHD$_3$ in [illegible] subjects; the mean change in 7 subjects who rece[illegible] artificial U.V.L. is also shown. A number of "weekly" values were derived by intrapolation of levels obtai[illegible] up to three to four days on either side of the week in question. 25-OHD$_3$ again showed the same order of superior potency over vitamin D in increasing circul[illegible] ing 25-OHD. Changes with U.V.L. again were similar to those in patients receiving oral vitamin D 10 000 I.U. daily.

Discussion

Experimental studies indicate that 25-hydroxylation of vitamin D is product-inhibited as well as being subject to other pronounced but poorly understood constraints; together these effects produce a "bottleneck".[7-9] In the present short-term and long-term studies the administered dose of vitamin D needed to be ten times larger than the dose of 25-OHD$_3$ to have the same effect on plasma-25-OHD. This indicated the extent of the constraints on 25-hydroxylation. Muscle and adipose tissue stores of vitamin D are said to be large:[13] preferential uptake of the parent vitamin(s) in these tissues could additionally limit their availability for 25-hydroxylation. The mathematical relation between vitamin-D dosage and plasma-25-OHD is similar to that previously reported between dosage and circulating antirachitic activity measured by bioassay.[14] Since patients were included in the present study if they had a disorder expected to interfere with intestinal absorption or hepatic 25-hydroxylation or if their compliance with treatment was in doubt, our data may be of some value in assessing these disturbances in others.

25-OHD$_3$ is rapidly absorbed from the gastrointestinal tract[15] and we were unable in the present study to control the time interval between ingestion and sampling. Nevertheless constant daily dosage seemed to increase circulating concentrations at a rate similar to

achieved by a dose of vitamin D that was at least ten times greater. Plateau concentrations were achieved in six weeks with 25-OHD_3, whereas with vitamin-D treatment this could take four months, and similar periods of time were required for concentrations to return to the physiological range on stopping treatment (unpublished).

Changes in plasma-25-OHD during long-term solar irradiation[10] or short-term ultraviolet therapy[11,12] have been previously reported. The present comparison now shows that these changes are equivalent to those produced by a daily dose of 10 000 I.U. oral vitamin D in—i.e., 100 times the recommended daily adult dietary intake.[16] While there are several reservations against accepting this figure as representing endogenous synthesis, including the relative availability to liver of endogenous and exogenous vitamin D, our data raise a further aspect of vitamin-D economy, namely that synthesis of considerable amounts of the pro-hormone[6] in summer coupled with the pronounced constraints on its subsequent 25-hydroxylation may provide some protection against deficiency in winter.

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Reviews of Books

The Treatment of Venous Disorders

Edited by JOHN T. HOBBS, St Mary's Hospital, London. Lancaster: M.T.P. 1977. Pp. 438. £12.50.

COMING during a spate of publications on the pathology and surgery of the venous system, this book might easily have been repetitive. That it is not is a credit to its editor. By collecting an international panel of experts he has filled in many gaps not covered in British textbooks and has expanded many aspects of the subject which have already been dealt with. The title is misleading, for a good deal more than treatment is dealt with. There are contributions on ætiology, prevention, and radiological investigation, isotope screening, and venous-pressure measurements in the investigation of peripheral venous disorders. The seven contributions on the treatment of varicose veins are especially good: seven authors from seven countries vary widely, if predictably, in their use of surgery and injection sclerotherapy. K. Sigg from Switzerland is the chief advocate for sclerotherapy, while R. A. Nabatoff from the U.S.A. condemns all but operative surgery. F. Bezzouni of Russia has an approach similar to that of most surgeons in Britain—injection sclerotherapy for small, below-knee varices and high ligation and stripping for gross main-stem incompetence. Mr Hobbs' own controlled trial with similar conclusions constitute the bulk of his contribution on the subject. It is a pity that the prevention and treatment of deep-vein thrombosis could not similarly have been dealt with by a series of authors, but the subject is now so large and opinion so divided that a most unwieldy volume would doubtless have resulted. A. N. Nicolaides, I. Gordon-Smith, and J. D. Lewis deal clearly with these subjects. Although low-dose subcutaneous heparin is preferred in prophylaxis, other methods are fully described and given fair coverage, but not everyone will agree that compression bags and dextran give rise to logistic problems or circulatory overloading. Vascular surgeons will be mostly interested in the second half of the book. Here the difficult subjects of major vein replacement in venous trauma and in the postphlebitic syndrome are dealt with by J. Vollmar of Germany, A. V. Pokrovsky and L. I. Klioner of Russia, E. A. Hushi from Ohio, and R. W. Hobson, H. M. Rich, and C. B. Wright from Washington, U.S.A. These subjects have not previously been dealt with in depth in any English language textbook and certainly not by a similarly distinguished international panel of experts. The result is most stimulating for those with a special interest in these difficult problems. Parsons of St. Mary's Hospital contributes an elegant chapter on the history of venous transplantation. The book is well produced and well illustrated, and its editor and publishers are to be congratulated.

Quality Control in Clinical Chemistry

T. P. WHITEHEAD, PH.D. department of clinical chemistry, Queen Elizabeth Medical Centre, Birmingham. London and New York: Wiley. 1977. Pp. 130. £11, $18·50.

THIS is a personal account of some important aspects of quality control, based on experience gained from the work of hospital routine clinical-chemistry laboratories, but with the message clearly intended also to influence the practice of clinical research laboratories. The book is easy to read, but in parts it is surprisingly insubstantial, especially considering its price. To profit from it, readers must be prepared to accept Professor Whitehead's dogmatic, colloquial, and sometimes repetitious style; they must also be on the look out for the many proof-reading errors, mostly minor but occasionally liable to mislead seriously. Readers must also accept the author's decision to attach a new meaning to the term "variance", different from the meaning that is well established in statistical usage; variability or unreliability would have served his purpose equally well. Fundamental concepts that could have been better explained include accuracy and imprecision, and the difference (if there is one) between true results and correct values is not made clear. In this area terminology is important; for clarity of communication, the author should have adhered closely to internationally recommended definitions. The subdivision of techniques of quality control into five stages, each clearly explained, is the most valuable contribution of this book to future improvements in the reliability of clinical chemistry—indeed, the first four stages can be applied to other laboratory disciplines. The other feature to commend especially is the comprehensive account of the U. K. National Quality Control Scheme, as an example of the fifth stage of quality control. The U. K. scheme is a system of interlaboratory (external) quality control that is associated with Professor Whitehead, and one in which clinical chemistry has given an important lead to other laboratory disciplines. The chapters on the national scheme bring together, and add to, accounts that have been published in journals. These are the aspects for which the book can be particularly commended, since the subjects described fill important gaps in the already voluminous literature on quality control.